

External wall insulation of mobile homes



- A reduction of up to 30% in fuel costs and carbon dioxide emissions
- A typical increase in average air temperatures of 1.5°C
- Enhanced appearance and reduced maintenance costs



ENERGY EFFICIENCY

**BEST PRACTICE
PROGRAMME**

INTRODUCTION

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The benefits of applying external wall insulation (EWI) to residential mobile homes have been demonstrated by a pilot project carried out by Wyre Borough Council in Lancashire. Occupants have experienced improvements in thermal comfort and reduced fuel bills, by up to 30% in some cases. Based on the success of the pilot scheme, Wyre Borough Council applied for and received funding through the Energy Saving Trust's HECAAction scheme to establish a loan scheme for residents to help meet the cost of the insulation work.

There are approximately 200 000 mobile homes in the UK, many of which are occupied by low-income households. Mobile home sites do not often have mains gas available, consequently more expensive heating fuels, such as liquified petroleum gas (LPG) and electricity, are widely used. Older mobile homes typically have poor standards of thermal insulation and are, therefore, inefficient and expensive to heat with high carbon dioxide (CO₂) emissions.

Until 1996, mobile homes did not qualify for any grant funding for home improvements as they were classified as temporary structures, however they have since been eligible for some grants as temporary structures with permanent residences.

THE PILOT PROJECT

Wyre Borough Council started a pilot project in 1997 to improve the energy efficiency of seven mobile homes by applying EWI. Homes of different ages and occupancies, and of single- or double-bay frontage, were included. Two external wall systems were tried and both were successfully used. However, in subsequent work one system has proved more cost-effective.

The installation proved very popular with the occupants, who reported noticeable improvements in the internal air temperature and reductions in fuel bills. In some instances where LPG was the main fuel for heating, 30% reductions were achieved. The Council commissioned a short period of before and after temperature monitoring in one mobile home. This indicated an overall increase in average internal air temperature of 1.5°C. Since this time, some occupants have also noticed an improvement in comfort conditions during the summertime.

The homes improved were all older mobile homes (at least 10 years old) and the application of the EWI has helped to reduce the amount of exterior maintenance, a concern to many of the older occupants. The rendered finish, particularly where this is enhanced with artwork, improved the overall appearance of the homes and the appearance of the sites as a whole.

The Council and the occupants judged the pilot a success, therefore Wyre Borough Council applied to the Energy Saving Trust for assistance with funding a loan scheme under HECAAction. The interest-free loan scheme would help eligible occupants meet the cost of the EWI, and in some cases would be topped up by the Council with a small repair grant. The Council's application was successful and a loan scheme was put in place from 1999.

Before EWI treatment.

The front cover shows after EWI treatment



EXTERNAL WALL INSULATION

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External wall insulation improves the thermal performance of the wall by reducing the rate of heat loss and reduces the effects of thermal bridges (localised areas of increased heat loss) within the wall construction. The reduced rate of heat loss improves the inner wall surface temperatures and helps to alleviate problems of condensation and mould growth.

The system used since the pilot project has a polyurethane insulation board finished with a liquid polymer, fibre-reinforced plastic render coating.

A unique feature of this system is the use of graded shells and cullite (silicon chips) in the dash finish, which gives a much smoother finish than a conventional aggregate dash finish.

The system uses polyurethane (CFC-free) insulation boards, 30 mm thick, which typically improves the thermal transmittance (U-value) of the wall to 0.57 W/m²K. A wide range of board thicknesses are available and better U-values could be achieved if required.

An assessment of buildability issues identified only minor items. In a few cases, an incorrect trim profile was being used around windows, which

A typical installation using a polymer-modified render finish would be as follows.

- The existing external surface is cleaned and rainwater pipes, aerials, etc, are temporarily removed.
- Bell cast trims and trimming profiles are screw fixed around all window and door openings and along the lower edge of the mobile home.
- The insulation boards are fixed mechanically using approved fixings. Holes are drilled through the boards and substrate and the fixings hammered in. Typically, eight fixings are used in a full board positioned in a 3-2-3 configuration. Board fixing starts from the lowest point and continues until the whole exterior surface is covered.
- When all boards have been secured a base coat is trowel-applied to an approximate thickness of 3.5 mm and the reinforcing mesh is embedded in the base coat. A topcoat of approximately 4-6 mm is applied and finished with a shell-dash. Any artwork requested by the homeowner is applied at a later stage.
- The installation is completed by re-fixing the rainwater pipes, etc.

Typical mobile home before EWI is applied



allowed water to collect below the window causing staining of the PVC-U trim and windows. Subsequently, a number of expansion joints have shown 'snaking' of the silicone sealant. To resolve this problem, an alternative jointing product has now been specified.

The durability of the system has been assessed by the British Board of Agrément (BBA) and shown to be durable for at least 30 years, assuming normal maintenance. It is likely that the installation will help to extend significantly the life of a mobile home. It is also reasonable to assume that the level of maintenance required by the render system would be lower than a conventional painted exterior, which would typically need re-painting every five years.

ASSESSMENT OF ENERGY EFFICIENCY

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An assessment of the energy efficiency of the mobile homes before and after refurbishment with the EWI has been made. The analyses have been carried out using software based on BREDEM-12. BREDEM has been shown to predict energy use to within $\pm 5\%$ in 95% of cases (see box below right).

Assessments have been carried out representing an 'old' home (>20 years) and a 'modern' home (<5 years). For the modern home, two types of heating system have been assessed – an LPG back boiler system and a mains gas combination boiler. Heating patterns and temperatures have been based on the temperature monitoring and information supplied by the occupants.

The results of the analyses are presented in terms of the annual fuel use and costs for space heating and the CO₂ emissions associated with the fuel use. The results are shown in table 1.

ASSUMPTIONS FOR BREDEM ASSESSMENTS

The following assumptions have been made about the mobile homes, the heating systems, occupancy patterns and periods of use.

- An 'old' home is 20 or more years old, with no insulation to the external walls, floor or roof. It has replacement PVC-U double-glazed windows. Heating is supplied via a LPG-fired back boiler and a focal fire in the living room. An on-peak immersion heater provides hot water. Heating is required 16 hours a day with an average whole-house temperature of 15.2°C.
- A 'modern' home is less than five years old with walls, floor and roof insulated to a moderate level and double-glazed windows. The heating system is either a mains gas combination boiler, supplying both heating and hot water, or an LPG system as described above. Heating patterns and temperatures are as described above.

	Space heating energy use (GJ/year)	Cost (£/year)	CO ₂ emissions (tonnes/year)
Mobile home >20 years, LPG heating without EWI	115	1090	10.0
Mobile home >20 years, LPG heating with EWI	80	770	8.0
Savings	35	320	2.0
Mobile home <5 years, LPG heating without EWI	40	370	5.5
Mobile home <5 years, LPG heating with EWI	30	310	5.0
Savings	10	60	0.5
Mobile home <5 years, mains gas heating without EWI	43	170	3.5
Mobile home <5 years, mains gas heating with EWI	36	145	3.0
Savings	7	25	0.5

Table 1 Summary of energy, cost and CO₂ emissions savings for typical double-frontage mobile homes

The results of the energy efficiency assessment have shown that for an old mobile home with LPG as its primary heating fuel, savings of up to 30% in fuel use can be achieved with a similar reduction in CO₂ emissions. Savings are lower in more modern mobile homes due to the improved standards of insulation. The assessment takes no account of the improvement in average whole-house temperature. From the temperature monitoring carried out, an improvement of 1.5°C was measured. Taking account of this in the assessment, savings for the old mobile home are reduced to 15 GJ/year (13%). All the energy benefit is accounted for in the modern mobile home by the improvement in temperature.

With installation costs of approximately £2000, simple payback periods are in the order of six years. However, this simple economic assessment takes no account of the reduced maintenance costs, the likely improvement in asset value or the extension in the life of the structure.

BREDEM

BREDEM is a simple but reliable method of estimating the energy use, and hence the energy efficiency, of dwellings. Model inputs include physical characteristics of the dwelling and heating system plus occupancy-related factors. BREDEM exists both as a worksheet and as computer programs to assist architects, designers and others who need to calculate dwelling energy use and the likely effects of energy efficiency measures. BREDEM underpins the Government's Standard Assessment Procedure for energy rating of dwellings, which is incorporated within current Building Regulations.

TEMPERATURE MONITORING

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A short period of temperature monitoring was carried out to assess the impact of EWI on the internal temperatures. Figures 1 and 2 show the data recorded in one of the mobile homes.

The average internal air temperature for a two-week period before the insulation was applied was 15.2°C, and after improvement it was 16.7°C. The average external air temperature during the second period of monitoring was slightly cooler

at 7.8°C compared with 8.7°C. This suggests that the occupant was able to maintain an improvement in air temperature of approximately 1.5°C following the application of the insulation.

Further temperature monitoring carried out in other mobile homes has indicated a more even distribution of heat throughout the homes, and in one instance enabled the occupant to maintain significantly higher internal air temperatures.

OCCUPANT OPINIONS

Short questionnaires were completed during interviews with residents of two mobile homes to indicate their reactions to, and perceptions about, EWI. The occupants were retired couples who were typically at home for most of the day. Both mobile homes were more than 10 years old and had only recently had the EWI applied. In addition to these interviews, informal discussions were held with a number of the residents whose homes had been improved during the pilot project.

- All occupants had a high level of awareness of their fuel costs. Fuel bills of between £400 and £600 prior to the EWI being fitted were not unusual.
- The occupants reported that condensation and mould growth were apparent prior to the EWI, although it was not considered to be a significant problem. In one home, condensation and mould growth had occurred on the floor and walls in the main bedroom.
- Occupants were generally happy with the installation work with any negative comments relating to the period of time taken to finish the work.
- Most occupants noticed an immediate positive effect on internal air temperatures within the homes and were satisfied with the levels of thermal comfort that they were able to achieve.

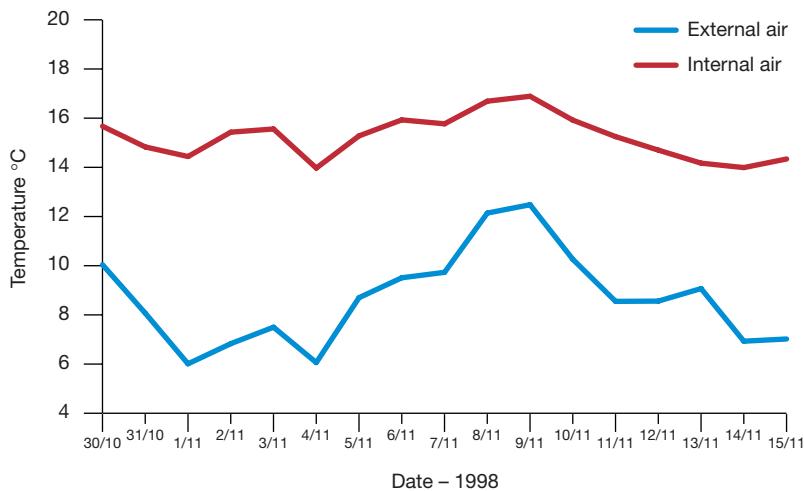


Figure 1 Before external wall insulation

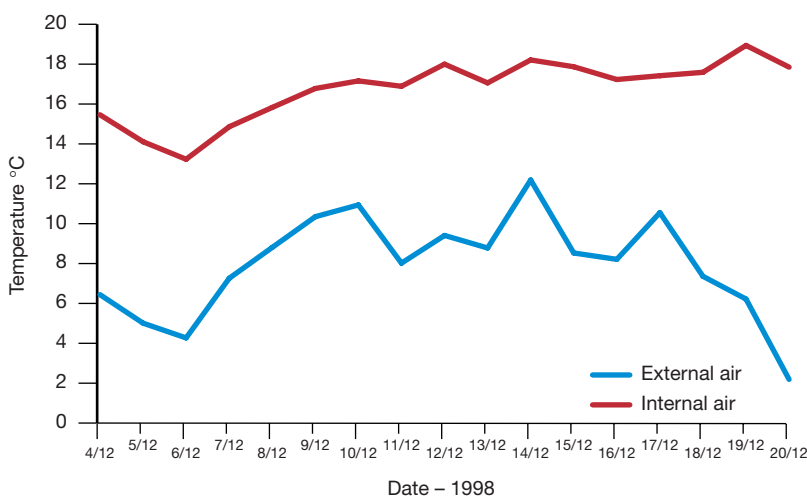


Figure 2 After external wall insulation

CONCLUSIONS AND FURTHER INFORMATION

CONCLUSIONS

The benefits of EWI when applied to permanent residential mobile homes have been demonstrated by a pilot project carried out by Wyre Borough Council.

Occupants of older mobile homes achieved fuel savings of up to 30% with a similar reduction in the associated CO₂ emissions and improvements in thermal comfort. Occupants indicated that, overall, they were happy with the installations and in one case had noticed an immediate improvement in air temperature.

A short period of temperature monitoring indicated that the occupants were able to maintain an improvement in average internal air temperature of approximately 1.5°C following the application of the insulation. The overall average air temperature in the mobile home following installation of the EWI was 17°C. At these levels the risk of surface condensation occurring will be significantly reduced.

The assessment of buildability did not highlight any significant difficulties with the installation of the EWI. Subsequent failures of some expansion joints have resulted in an alternative joint sealant being specified.

Non-energy benefits include the enhanced appearance of the mobile home, reduced exterior maintenance and an extension in the life of the structure.

FURTHER INFORMATION

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ENERGY EFFICIENCY BEST PRACTICE
PROGRAMME DOCUMENTS

The following Best Practice programme publications are available from the BRECSU Enquiries Bureau. Contact details are given below.

General Information Leaflet

- 31 Building Research Establishment Domestic Energy Model (BREDEM)

Good Practice Guides

- 155 Energy efficient refurbishment of existing housing
293 External insulation systems for walls of dwellings

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Energy Efficiency Best Practice in Housing

Tel: 0845 120 7799
www.est.org.uk/bestpractice

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